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FOREST RESEARCH NOTES

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FURTHER EXPERIMENTS IN SEASONING CALIFORNIA BLACK OAK

By H. H. Smith, Forest Products Technologist

The forest and lumber economy of California is based on the utilization of softwoods: ponderosa and sugar pines, redwood, Douglas-fir, and several other species. The hardwoods of the region have been utilized to only a limited extent. In recent years, however, interest has increased in closer utilization of the more promising hardwoods. Most hardwoods season less easily than do the softwoods. This fact apparently has led to the belief that the California hardwoods could not be seasoned without prohibitive drying degrade. Recent research in the seasoning of California black oak has shown that such a broad conclusion is not correct, for this species at least can be seasoned successfully.

PREVIOUS WORK

The first seasoning experiments of California black oak by the California Forest and Range Experiment Station were completed in the fall of 1948.1/ Because of the widespread belief that this oak could not be seasoned, the test material was sawed into 3/4-inch flooring strips, 3 inches and 6 inches wide. There appeared to be a reasonable chance for success in the experimental drying of these thin, narrow strips.

The flooring strips dried readily, without drying defects, both on the air-drying yard and in the dry kiln after being air dried. But these results had limited application. They only suggested that drying might succeed with thicker stock. Full 1-inch lumber is the thinnest size usually sawed for general use, so some work on stock thicker and wider than the flooring strips seemed desirable. A second series of tests was scheduled, and the results are reported here.

1/ Reported in Forest Research Note No. 62, California Forest and Range Experiment Station, 8 pp., July 1949.

* MAINTAINED AT BERKELEY, CALIFORNIA, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA.

Agriculture--Berkeley

TEST MATERIAL

The California black oak for this series of seasoning experiments was cut in August of 1949 in an area 30 miles northeast of Oroville, at an elevation of 2,500 to 3,000 feet. Seven trees were felled and bucked into 13 logs, from 10 to 16 feet in length. The logs were delivered by truck to a local mill where they were sawed on a circular head-saw into 4/4, random, width lumber. The boards were edged, but end-trimmed on one end only.

PILING FOR AIR DRYING

The green oak lumber was delivered to the Oroville yard of the High Sierra Pine Company where it was put over the green chain for grading and tallying. The grader was unable to grade by the National Hardwood Lumber Association rules for inspection, but a board measure was made and recorded. This measure showed a total of 4,200 board feet of lumber from the 7 trees (13 logs), which gives an average of 600 board feet per tree, or 323 board feet per log.

The rough, green lumber was piled in unit packages for air drying, using nine 1- by 2-inch stickers per course. A bottom, or foundation course of 8/4 white fir was laid down first in piling each unit of oak lumber. This precaution was believed advisable in order to keep the oak as flat and straight as possible.

The unit packages were moved with a fork-lift truck to the air drying yard where they were stacked three high on good pile foundations. Cover boards were placed over the top units to protect the lumber from the direct sun.

The three piles of oak lumber were further protected by piling units of pine on both sides, spacing all the piles 12 to 18 inches apart. The space between adjacent rows of piles was about 8 feet. Thus, surrounding piles of pine protected the oak from the full effects of the hot winds that prevailed in the area during the time the lumber was on the yard.

(Greater care is required in piling hardwood lumber for air drying than in piling softwood. Nine or more stickers are usually required. A diagram showing a method for piling unit packages of hardwoods and a diagram prepared by the U. S. Forest Products Laboratory for hand-piling hardwood lumber on the yard are attached to this report.)

MEASURING THE RATE OF DRYING

Sample boards were pulled while the lumber was moving over the green chain. These samples were selected to represent both fast drying and slow drying boards as well as others that appeared to be average in all respects.

Twelve samples were placed in the units of lumber on the yard in spaces or pockets provided for the purpose. Oven-dry weights of these samples were calculated to facilitate periodic moisture content determination.[2]

The samples were weighed and carefully examined periodically during the air drying period.

Specially prepared wood slivers, approximately 1/8-inch thick, 4 inches wide and 18 inches long were placed within the loads of lumber. A measure of the moisture content to which the lumber would dry within the pile was obtained by weighing these samples.

AIR DRYING RESULTS

The results of the air drying can be stated very simply without qualifying and limiting explanation: the results were excellent.

Surface checking did not develop as expected during the air drying. No good explanation is readily available, for there were many wide, flat-sawed boards that might be expected to check when exposed to the relatively severe air drying conditions that prevailed.

End checking was moderate to slight, far less than expected. The end checking in the oak was no more severe than in adjacent piles of pine, and little if any loss would result from end trim necessitated by the checking.

During the total drying time of 63 days on the yard (fig. 1), the average moisture dropped from 98.5 percent (maximum of 113 percent) to 17.3 percent (maximum of 26 percent). The usual air-drying time for eastern white and red oak is 70 to 240 days, the time being dependent on the season of the year, of course. For the eastern oak the average moisture loss (based on the shorter drying time) is approximately 1 percent per day. The average moisture loss for the California black oak was more than 1½ percent per day. Besides drying rapidly as compared to the rate for eastern oak, the California black oak dried on the yard under relatively severe drying conditions without defects.

KILN DRYING RESULTS

After preliminary runs in a small experimental dry kiln[3] to determine what temperatures and humidities could be used, the bulk of the material was dried in a commercial steam-heated kiln of conventional cross-circulation design.

2/ "The Use of Kiln Samples in the Operation of a Lumber Dry Kiln," U. S. Forest Products Laboratory report R1607.

3/ "Small Demountable-type Lumber Dry Kiln for Experimental Drying," U. S. Forest Products Laboratory publication R1671.

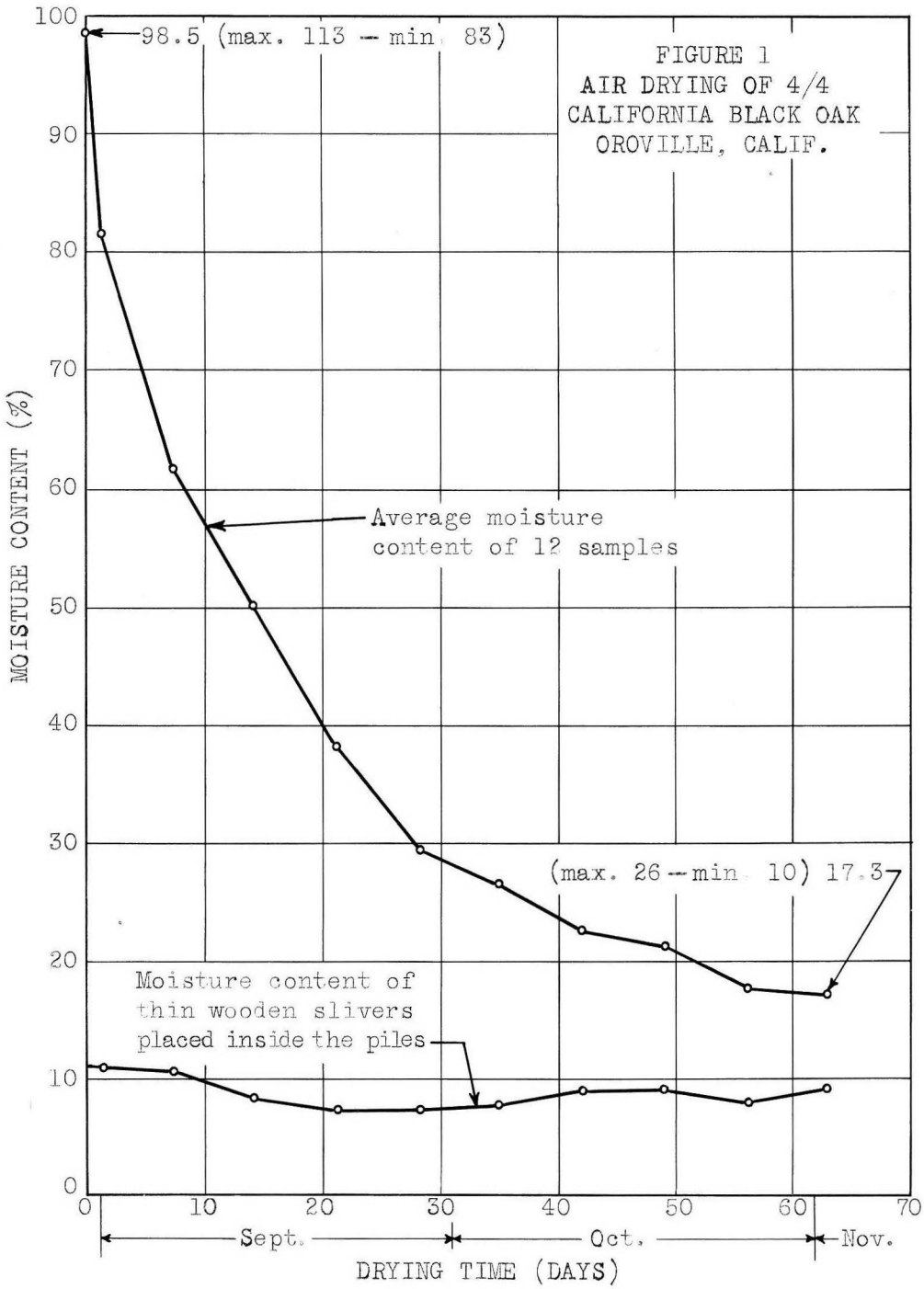


FIGURE 1
AIR DRYING OF 4/4
CALIFORNIA BLACK OAK
OROVILLE, CALIF.
98.5 (max. 113 — min. 83)
Average moisture
content of 12 samples
(max. 26 — min. 10) 17.3
Moisture content of
thin wooden slivers
placed inside the piles
MOISTURE CONTENT (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Sept.
Oct.
Nov.
DRYING TIME (DAYS)

Kiln Drying of Air-dried Stock

Previous experience indicated that stock which had been air dried to a moisture content of 20 percent or less could be kiln dried with relative ease. This fact was further substantiated by drying experiments in both the small experimental kiln and the larger commercial kiln.

Four-quarter, random-width stock from the air-drying yard at a moisture content of 21 percent was dried to a final moisture content of 8 percent in the small experimental kiln in 7½ days, including one day of conditioning to remove drying stresses (fig. 2).

Drying defects in this run were negligible. There was no checking, honeycomb, or collapse, and the final range of moisture content was from 7.2 to 9.4 percent. The lumber was stress-free after the conditioning treatment.

By the time the bulk of the oak lumber was loaded into the commercial kiln, it had further air dried to a moisture content of 17.3 percent.

There was not sufficient lumber to make up a full kiln charge, so the five units of oak were dried along with units of 6/4 sugar pine, using a predetermined schedule calculated to be reasonable for both the air-dried oak and the green pine. Faster drying could no doubt be done by using a more severe schedule, and judging from the results obtained thus far in the kiln drying of previously air-dried stock, equally good results could be expected.

The results of this run in the commercial kiln were good (fig. 3). There was no loss from the usual drying defects (checks, splits, collapse, warp, etc.). The lumber was fairly stress-free after the final conditioning treatment. Some boards in this charge were mis-cut, being considerably thicker than 4/4. These thick boards naturally dried more slowly and had a higher final moisture content. In these boards the conditioning treatment did not relieve the drying stresses completely. More uniform drying and more uniform relief of stress can be expected when drying lumber that is manufactured to a more uniform thickness.

Kiln Drying Green-from-the-saw

One attempt to kiln dry a charge of this 4/4 California black oak green-from-the-saw was not successful. A reasonably mild drying schedule was used yet very poor results were obtained, indicating that in kiln drying California black oak green-from-the-saw a very mild drying schedule will be required. Such a schedule when used in a modern kiln capable of accurate control of drying conditions would no doubt produce well-dried lumber. But as the drying time would be increased, such an operation would be less attractive than a combination of air drying following by kiln drying.

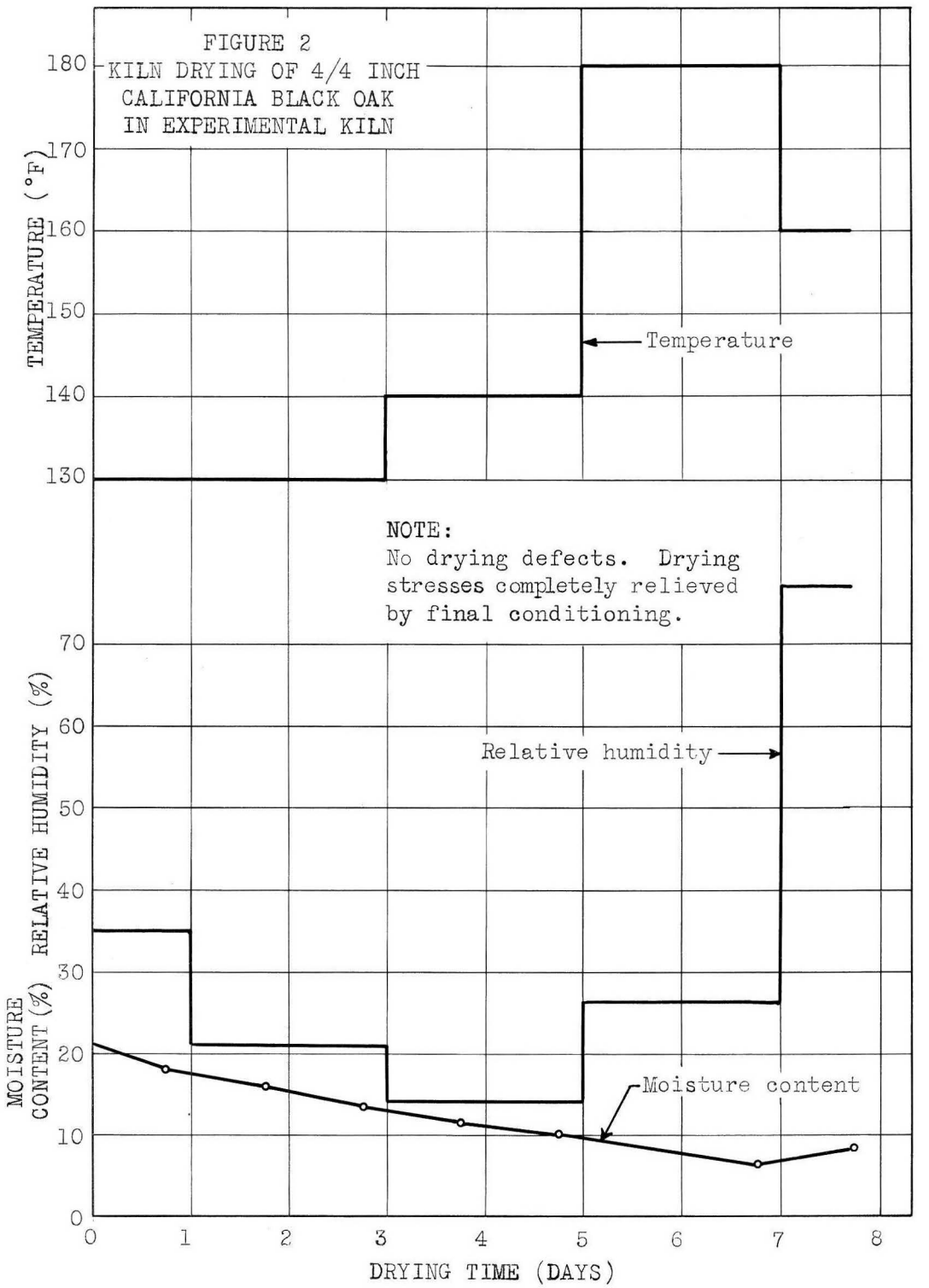


FIGURE 2
KILN DRYING OF 4/4 INCH
CALIFORNIA BLACK OAK
IN EXPERIMENTAL KILN
TEMPERATURE (°F)
180
170
160
150
140
130
Temperature
NOTE:
No drying defects. Drying
stresses completely relieved
by final conditioning.
RELATIVE HUMIDITY (%)
70
60
50
40
30
20
10
0
Relative humidity
MOISTURE CONTENT (%)
Moisture content
0
1
2
3
4
5
6
7
8
DRYING TIME (DAYS)

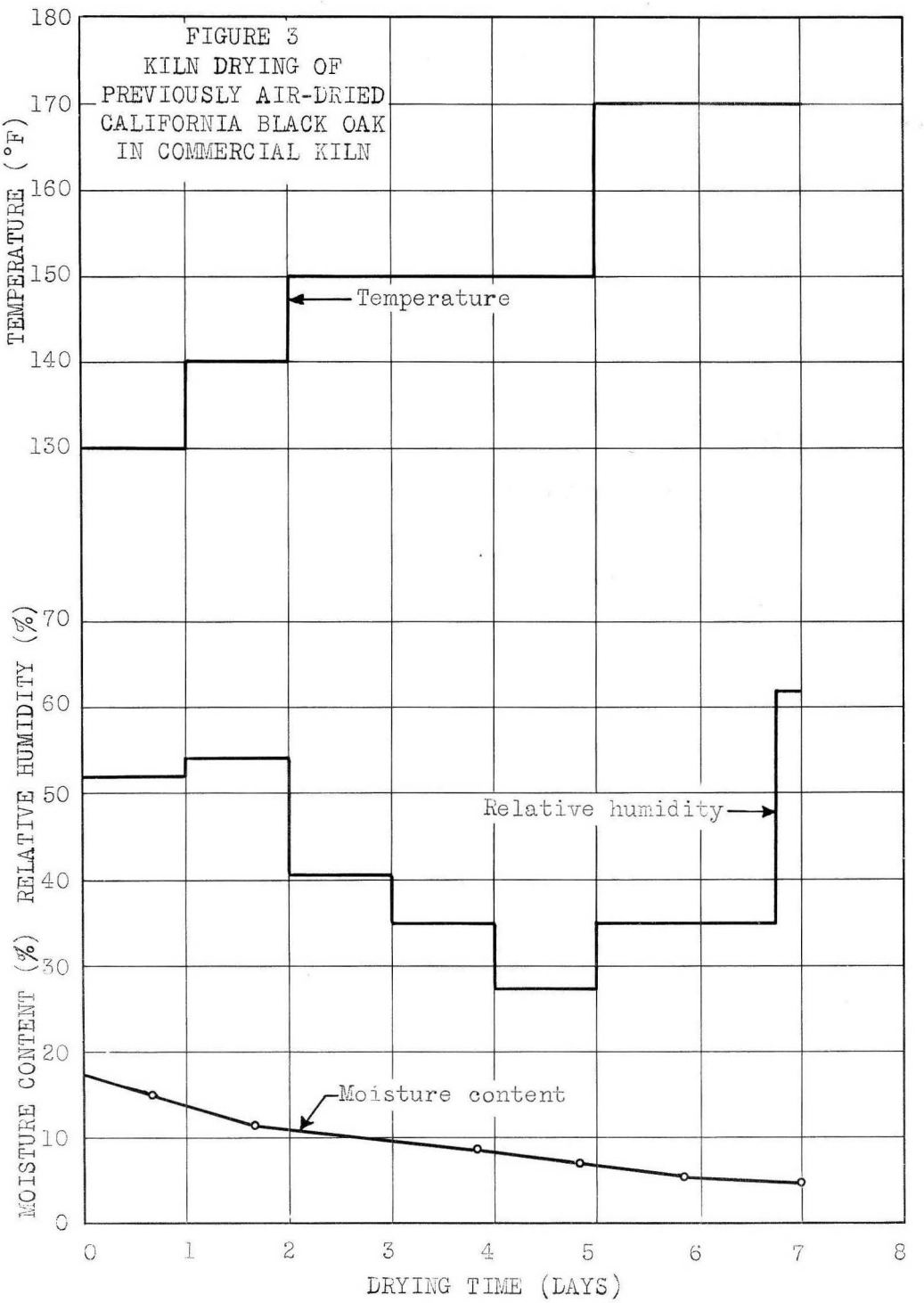


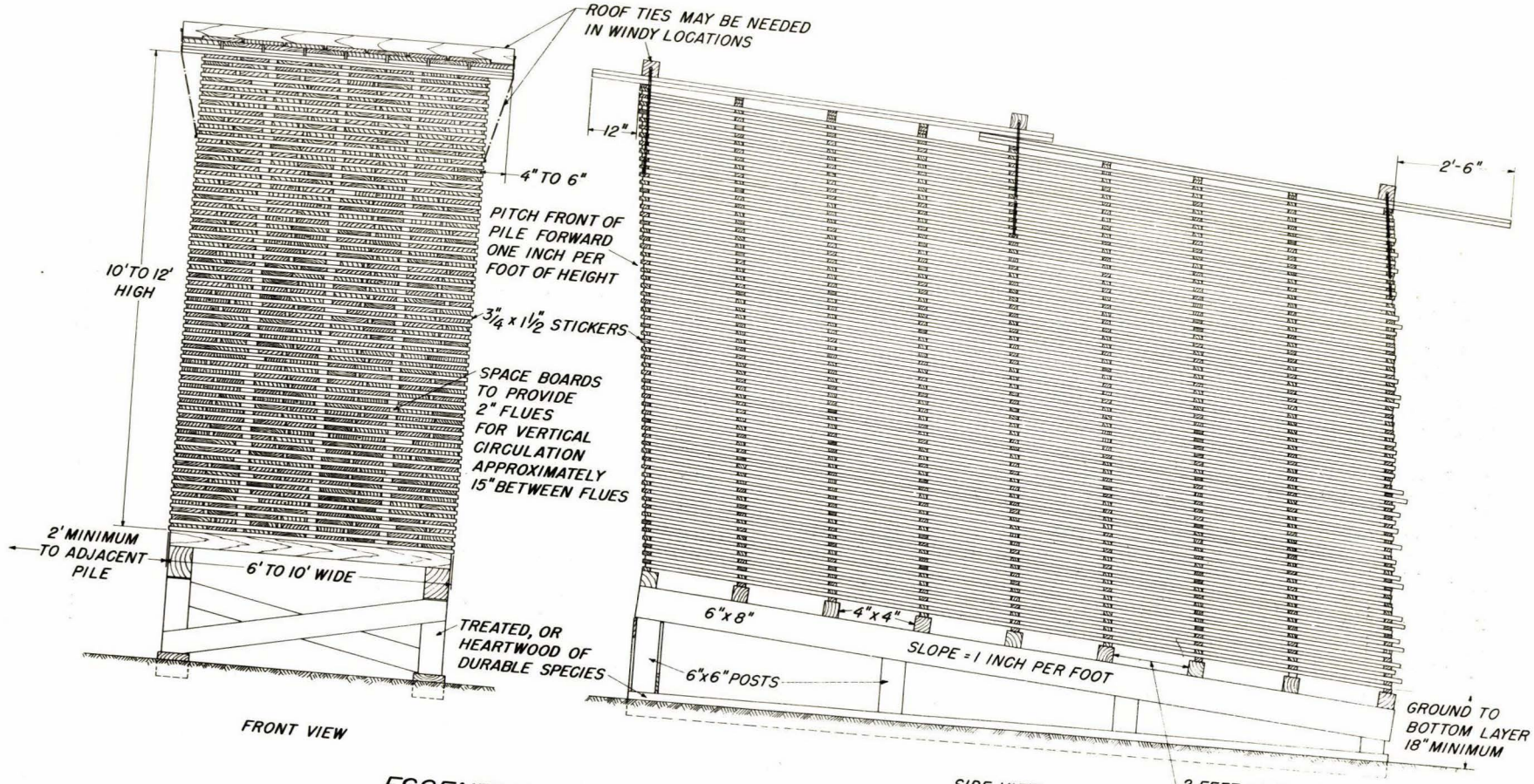
FIGURE 3
KILN DRYING OF
PREVIOUSLY AIR-DRIED
CALIFORNIA BLACK OAK
IN COMMERCIAL KILN
TEMPERATURE (°F)
180
170
160
150
140
130
Temperature
RELATIVE HUMIDITY (%)
70
60
50
40
30
Relative humidity
MOISTURE CONTENT (%)
20
10
0
Moisture content
0
1
2
3
4
5
6
7
8
DRYING TIME (DAYS)

Drying degrade in the form of collapse and excessive warping developed during this experimental kiln run to such an extent that much of the lumber was completely spoiled. These unfavorable results indicate that the drying temperature is of considerable importance and that even the mild initial kiln temperatures (120° F) weakened the wood sufficiently to cause serious warping and collapse. Surface checking, on the other hand, was not severe, indicating that in kiln drying similar material a lower temperature schedule, with the same humidities, might be expected to produce better results.

CONCLUSION

The first experiments in the air drying and kiln drying of California black oak showed that it can be seasoned readily in the form of 3/4-inch flooring strips, 3 and 6 inches wide. Further experiments show that it can also be seasoned readily as full 1-inch thick boards up to 14 inches wide. Though thicker sizes can no doubt be seasoned successfully also, there appears to be little need to do so. There are good markets for large quantities of inch-thick oak lumber.

These experiments show that California black oak can be seasoned by well established, conventional methods, and that seasoning should not be a limiting or retarding factor in more complete utilization of this species.


ROOF TIES MAY BE NEEDED IN WINDY LOCATIONS
12"
4" TO 6"
2'-6"
PITCH FRONT OF PILE FORWARD ONE INCH PER FOOT OF HEIGHT
10' TO 12' HIGH
3/4" x 1 1/2" STICKERS
SPACE BOARDS TO PROVIDE 2" FLUES FOR VERTICAL CIRCULATION APPROXIMATELY 15" BETWEEN FLUES
2' MINIMUM TO ADJACENT PILE
6' TO 10' WIDE
TREATED, OR HEARTWOOD OF DURABLE SPECIES
6"x8"
4"x4"
SLOPE = 1 INCH PER FOOT
6"x6" POSTS
GROUND TO BOTTOM LAYER 18" MINIMUM
FRONT VIEW
SIDE VIEW
2 FEET OR LESS BETWEEN STICKERS FOR 6/4 OR THINNER LUMBER

ESSENTIAL FEATURES IN PILING FOR AIR SEASONING

INTENDED MAINLY FOR HARDWOOD LUMBER THAT IS PRONE TO CHECK
(SEE INSTRUCTIONS ON REVERSE SIDE)

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
MARCH 1947

Z M 72541 F

R-1672

FOREST PRODUCTS LABORATORY

INSTRUCTIONS IN FLAT PILING TO TAKE CARE OF VARIATIONS IN LOCAL CONDITIONS AND IN SPECIES AND SIZES OF STOCK

To reduce the occurrence of:

Checking	Warping	Blue stain and decay
Note: A relatively slow initial drying rate is needed.	Note: Proper support and freedom from external forces are needed.	Note: Fast surface drying is needed or chemical treatment.
1. Use wider piles or a double-pile on a common foundation.	1. Place stickers in exact alinement over good foundation members.	1. Reduce width of pile.
2. Use minimum space between piles (2 feet).	2. Use close spacing between stickers, such as 16 inches.	2. Increase width of flues.
3. Use minimum width of flues (1 inch).	3. Use stickers of uniform thickness.	3. Increase space between piles.
4. Pile boards edge to edge as nearly as possible in upper part of pile.	4. Avoid big variations in board thickness in any one layer.	4. Provide 6 feet or more between rear end of piles.
5. Use minimum thickness of stickers (1/2 inch).	5. Use a roof that provides good protection from sun and rain.	5. Keep yard clean and avoid blocking air space below piles.
6. Use wider projecting stickers in front and rear of pile.	6. Provide some weight on top of pile to hold down top layers.	6. Use a chemical dip (see Forest Products Laboratory Technical Note 225).
7. Use shields around pile to protect against wind, rain, and sun.	7. In drying random length lumber, avoid unprotected and unsupported overhanging ends by sorting for length or by box piling.	
8. In drying random length lumber, avoid unprotected and unsupported overhanging ends by sorting for length or by box piling.		
9. Use end coatings.		

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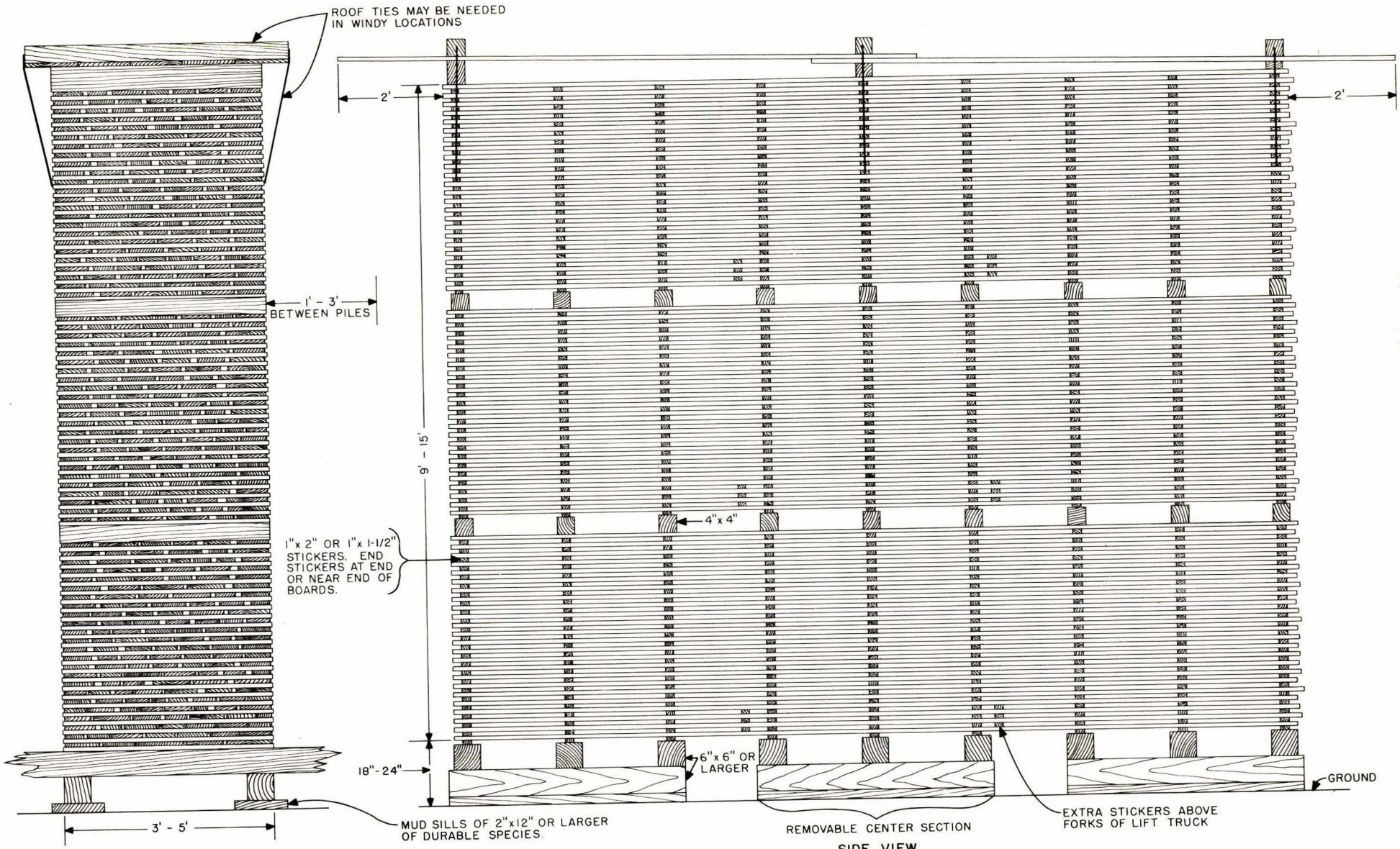
ROOF TIES MAY BE NEEDED IN WINDY LOCATIONS
2'
2'
1' - 3' BETWEEN PILES
9' - 15'
4"x 4"
1"x 2" OR 1"x 1-1/2" STICKERS. END STICKERS AT END OR NEAR END OF BOARDS.
18"-24"
6"x 6" OR LARGER
GROUND
3' - 5'
MUD SILLS OF 2"x12" OR LARGER OF DURABLE SPECIES.
REMOVABLE CENTER SECTION
EXTRA STICKERS ABOVE FORKS OF LIFT TRUCK
END VIEW OF UNIT PACKAGES
SIDE VIEW

UNIT PACKAGE PILING FOR YARD DRYING

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE - U. S. DEPARTMENT OF AGRICULTURE
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